RESEARCH HIGHLIGHT

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Technical Series 09-107

Monitoring Results for the Factor 9 Home

INTRODUCTION

The Factor 9 Home: A New Prairie Approach is a demonstration project consisting of a single family residence located in Regina, Saskatchewan, Canada, which features very high levels of energy and water use efficiency. The home was completed in April 2007.

A previous CMHC Innovative Buildings Case Study entitled "Factor 9 Home: A New Prairie Approach" (CMHC 2007) provides information on the design of the home and photos of the construction. Additional information on the house is available at www.factor9.ca.

Energy and water savings targets were established for the Factor 9 Home. The Factor 9 Home was targeted to use a factor of nine times less energy per square metre of floor area than the average existing home in Saskatchewan (circa 1970). The resulting energy target was 30 kWh/m^2 per year (108 megajoules/m^2-year) of total purchased energy consumption. Another numerical performance target for the home is a Factor 2 reduction in purchased water consumption from the utility compared with conventional homes.

Energy and water use was monitored for a one-year period ending May 31, 2008.

To assess the extent to which the performance objectives were met, CMHC in collaboration with NRCan and other stakeholders, supported a project to monitor energy and water use for a one-year period ending May 31, 2008. A number of indoor air quality indicators were also measured. The findings of this project are summarized below.

ENERGY CONSERVATION FEATURES

The house features a very energy conserving envelope, with an insulation level of RSI 14.1 (R80) in the attic, RSI 7.2 (R41) above grade walls and RSI 7.7 (R44) on basement walls. At the rim joist, the insulation level is RSI 4.7 (R26.9). The building is well sealed, with a measured air tightness level of 1.2 air changes per hour at 50 pascals, which is tighter than the R-2000 standard of 1.5 ac/h at 50 Pa.

Passive solar heating is used to provide part of the space heating and is projected to provide 41% of the total annual space heating requirement. The lot for the home was chosen so as to have the rear of the house face south for passive and active solar gain. Active solar heating is provided by 20.4 square metres of double glazed vertical solar panels mounted on the south wall of the house. The south wall faces 26 degrees east of due south. A 2,350 litre water storage tank in the basement is used to store the heat from the solar panels. To distribute the space heating, a fan coil with brushless direct current motors is used.

Figure 1 The Factor 9 Home viewed from the south east. The view is of the back side of the house. The solar thermal panels (1.5 metres tall) are in a horizontal band between the upper and lower windows.

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HOME TO CANADIANS

The active solar panels are used to provide part of the domestic water heating and space heating. A passive drain water heat exchanger is used to preheat domestic hot water prior to the solar storage tank. An instantaneous electric heater is used to provide the auxiliary energy needed for domestic water heating.

To provide mechanical cooling in the summer, a network of plastic pipes was installed in 22 of the 33 concrete pilings supporting the foundation in order to extract cooling from the ground. As the approximate annual ground temperature at the base of the pilings is about +5°C., the water in the plastic pipes can provide space cooling for the house. The same fan coil used for space heating is also used for space cooling. Manually operated valves are used to switch from the space heating to the space cooling mode.

Energy efficient compact fluorescent lights and Energy Star™ appliances are used in the house.

WATER CONSERVATION FEATURES

Rainwater and melted snow water runoff from the roof is stored in two 9,500 litre tanks in the crawl space beneath the basement floor. This non-potable water is used for ultra low flow toilets and exterior water needs. Landscaping was designed to reduce the need for water.

PERFORMANCE RESULTS

Over the one-year period of occupied monitoring, the measured purchased energy consumption of the house was 33 kilowatt-hours/square metre of floor area. In comparison, a typical home of the same size built in 1970 would have a consumption of 331 kWh/m^2, or ten times as much. A graphical comparison of the purchased energy consumption of the two houses is shown in Figure 2.

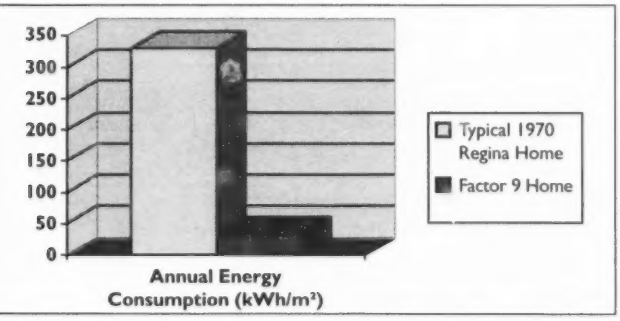


Figure 2 Comparison of the annual purchased energy consumption of a typical 1970 Regina Home with the Factor 9 Home

The purchased electrical energy consumption for the house amounted to 8,969 kWh for the period from June 1, 2007 to May 31, 2008. A graph of the daily purchased electrical energy consumption is presented in Figure 3.

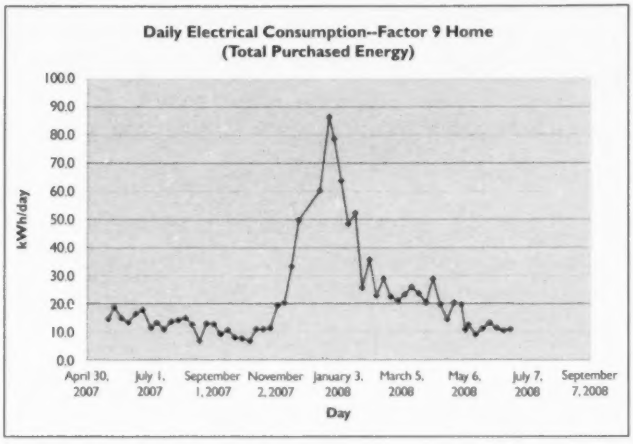


Figure 3 Purchased electricity consumption for the Factor 9 Home [Manual readings taken weekly]

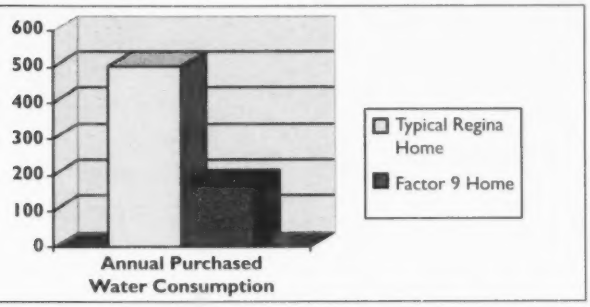
As can be seen from Figure 3, the peak daily electricity consumption for the house was 86.3 kWh/day [3.6 kW] for the one-week period ending December 25, 2007. This peak consumption is much smaller than the design heat loss for the house as calculated by the HOT-2000 computer program (10.5 kW at -34°C), as the HOT-2000 program calculation of the design heat loss contains three assumptions:

1. no passive solar contribution
2. no active solar contribution
3. no internal heat gain from people

The outside temperature for the week ending December 25, 2007 was warmer than -34°C. In addition to the electrical consumption in the house, a modest amount of wood was burned in an airtight wood fireplace. Over the monitoring period, the useful heat output from the wood consumption was calculated at 994 kWh.

The reduction in purchased water use by the home was also quite dramatic. For a family of 4 persons, the average water consumption in Canada is 501 cubic metres per year. For the one-year monitoring period, the measured water consumption of the Factor 9 Home was 171 cubic metres, a reduction in purchased water use of 66%. In the monitored

, the total precipitation was less than half of the long
n average of 388 mm for Regina, reducing the amount
vater available to the roof collection system. The exterior
dscaping for the home was not completed during the one
r of monitoring. Water collected from the roof is directed
wo membrane tanks with a combined volume of 22 cubic
res located in the crawl space beneath the basement floor.
e annual average rainfall in Regina on the roof of the
se is about 38 cubic metres.



ure 4 Comparison of the annual purchased water consumption of a typical Regina Home with the Factor 9 Home

CREMENTAL COST OF ENERGY AND ATER EFFICIENCY FEATURES

e homeowners did a substantial amount of the work on
house and were able to achieve discounts through their
fessional contacts. Thus, it is difficult to put a precise
mber on the incremental cost of the energy and water
ciency features. The incremental construction cost for the
rgy and water efficiency measures for the home was roughly
,000, or 12% extra, exclusive of land. The home includes a
mber of upgrades that increase the durability of the
ne, including a piling foundation in the Regina clay soil,
erior insulating brick cladding and upgraded asphalt
ngles. The water savings are $488 per year based on
rent water prices in Regina. The house does not use any
ural gas. The energy savings compared to a new home
imilar size located in Regina (that is heated with natural
) are estimated at $952 per year based on reference data
he CREEDAC database of homes built between 1998
l 2000. The combined energy and water savings amount
$1,440 a year based on current energy prices in Regina.
e rate of return on the incremental cost of the energy
l water efficiency features of the home is thus 3.9%
per annum based on current energy prices. This would be equivalent to a simple payback period of 26 years. In a number of Canadian provinces, substantial cash grants are now available to help reduce the incremental cost of the energy efficiency measures. These cash grants would improve the economics.

INDOOR AIR QUALITY

Well sealed residences cannot rely on natural ventilation to provide dilution of the pollutants generated indoors. The Factor 9 Home has a Heat Recovery Ventilator (HRV) to provide mechanical ventilation. Short term measurements of volatile organic compounds and radon gas in the home were made.

The Total Volatile Organic Compound (TVOC) reading for the house over a two-day interval was 5.4 milligrams/cubic metre of air.

Canada does not currently have a residential guideline for indoor TVOC values. However, the European value that is sometimes quoted is a guideline of 0.3 milligrams/cubic metre of air. The relatively high reading for TVOC in the Factor 9 Home was no doubt strongly related to the extensive painting that occurred in the basement just prior to the measurements.

Radon values were measured using a factory calibrated digital readout device — the Safety Siren Pro 3™ Radon Detector. Over the period from April 6, 2008 to June 22, 2008, the weekly radon readings measured on the main floor of the house varied from a low of 41 to a high of 70 Becquerels per cubic metre. The current Canadian guideline for radon is 200 Becquerels per cubic metre.Thus the radon gas levels were well below the Canadian guideline.

SUGGESTED IMPROVEMENTS TO THE FACTOR 9 HOME

Two additional energy conservation measures that could improve energy performance of the house are: additional RSI 1.8 insulation in wood truss basement floor, and the addition of more insulation to the thermal storage tank for the active solar heating system. With these measures, the annual energy consumption for the house is projected to meet the 30 kWh/m^2 purchased energy target.

CLUSIONS

low energy and water use detached house was
strated in the Canadian Prairie Region. The house
ased high levels of energy efficiency, renewable energy
ater efficiency with proven technologies. The
ental cost of the energy and water upgrades was
ely modest at about 10%. Although not net zero
in performance, the house could be upgraded to near
o performance at a later date with the addition of
oltaic panels on the south facing roof. The placement
solar thermal panels on the vertical south wall resulted
external appearance that fit in well with the
nding homes.

LICATIONS FOR THE HOUSING USTRY

ctor 9 Home demonstrated the technical feasibility of
es that can significantly reduce household energy and
onsumption. Furthermore, the project demonstrated
e incremental costs were not overwhelming. The
could, in the future, install photovoltaic (PV) panels
onse to reduced PV costs or increased energy costs.

RENCES

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Prairie Approach." Canada Mortgage and Housing
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Housing Research at CMHC

Under Part IX of the ***National Housing Act***, the Government of Canada provides funds to CMHC to conduct research into the social, economic and technical aspects of housing and related fields, and to undertake the publishing and distribution of the results of this research.

This fact sheet is one of a series intended to inform you of the nature and scope of CMHC's research.

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